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J. S. Yuill
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THE ROLE OF THE NEEDLEMINER IN THE MANAGEMENT OF THE LODGEPOLE PINE FORESTS OF YOSEMITE

APPROVED BY:

J. M. MILLER
Senior Entomologist, In Charge

SUBMITTED BY:

J. S. YUILL
Assistant Entomologist

THE ROLE OF THE NEEDLEMINER IN THE MANAGEMENT OF THE LODGEPOLE PINE FORESTS OF YOSEMITE

INTRODUCTION

In 1911, Major Forsyth, then superintendent of Yosemite Park during the period of Army administration, requested the Bureau of Entomology to investigate an insect infestation which was causing serious defoliation of the lodgepole pine forest around Tuolumne Meadows. This is the first official recognition of the lodgepole pine needleminer (later described as Recurvaria milleri Busck.) as a forest enemy to be considered in the protection of this park for public recreational use.

At various times since that date, the Bureau of Entomology and Plant Quarantine has carried on investigations of several aspects of the problem. The distribution, habits and seasonal history have been determined; the effects of defoliation upon individual trees and upon stand conditions have been studied; and control methods have been tested experimentally.

In the summation of past and recent work, two questions then arise:

What part does the needleminer play in the general ecology, including age and type succession, in lodgepole pine stands?

To what extent does it affect aesthetic values and the present and future public use of park areas?

It is the purpose of this report to review the accumulated information that contributes toward an evaluation of conditions resulting from needleminer infestations and the policy best suited to dealing with the problem in protection and management of park areas.

PRESENT DISTRIBUTION AND STATUS

During the late summer and early fall months, practically all of the lodgepole pine stands within the park were covered by a cooperative reconnaissance of Park Service and Bureau personnel. The areas traversed and the conditions observed have been reported in detail by Assistant Forester Emil F. Ernst of Yosemite National Park and will be mentioned only briefly.

In general, the needleminer seems to be restricted to the Tuolumne and Tenaya drainages, but here it is present in practically all stands within the favorable altitude range (7,000 to 9,000 feet), mostly in a very low endemic state. In many stands, even though no living miners could be found, persistent search nearly always netted a few needles with empty mines, indicating that there must have been a few live individuals somewhere nearby.

Active infestations were found as follows:

Epidemic State	Sub-epidemic State	Epidemic State
Benson Lake Drainage	Upper Virginia Canyon	Murphy Creek
Rodgers Canyon	Pleasant Valley	Alkali Creek
Upper Breeze Creek	Stubblefield	Wilson Creek
(Sec.31, T 1 N, R 22 E)	Delaney Creek	Upper Matterhorn Canyon
Bear Valley	Forsyth Trail	Porcupine Flat
Kerrick Canyon	(Sec. 27, T 1 S,	Dog Lake
Forsyth Basin	R 23 E)	Rafferty Creek

Considering the entire area as a whole, the trend appears to be toward a static or a reduced condition; the epidemics in upper Breeze Canyon and Bear Valley have definitely passed the peak while the former epidemic center at Porcupine Flat has nearly disappeared. Aggressive epidemics continue in the Benson Lake drainage, Kerrick Canyon, Rodgers Canyon and Forsyth Basin, the latter definitely spreading southward. It was also noted in traversing the northern tributaries of the Tuolumne, the needleminer tends to persist from year to year in an endemic state in the upper canyons above old needleminer killed stands. Temperature conditions evidently prevent these infestations near the upper elevation limits from going into an epidemic state, but such infestations may well serve as reservoirs from which future epidemics may spread when conditions are favorable.

CONDITIONS UNDER WHICH EPIDEMICS OCCUR

Of the many epidemic centers which have been studied in the past twenty-seven years, all have been found to occur under certain conditions of stand age, elevation and site.

Age classes. Needleminer epidemics are found only in old, overmature park-like stands. Pole and sapling size trees may be heavily attacked if in close proximity to mature trees, but they soon recover after the epidemic subsides.

Elevation Range. No epidemics have been found below 7,000 or above 9,500 feet. The reasons for this limitation are not clear, but probably it is a function of environmental temperatures.

Site. The degree of injury is not the same throughout a given stand. Trees on poor sites, such as dry ridges, are most severely injured while those along streams and on the margins of meadows may be unharmed.

EFFECT OF NEEDLEMINER DEFOLIATION

Apparently lodgepole pines have very little reserve to carry them over periods of unusual adversity, and as a result, successive defoliations by the needleminer always produce a characteristic physiological unbalance.

Thinning of Crown. As the attack progresses from year to year, the mined needles die and fall away at a greater rate than new needles can be produced so that in a few years there remain only small tufts of short, stubby needles on the tips of the twigs. Infestation is heaviest in the top of the tree and the top gradually dies back as the epidemic continues. The least resistant trees will eventually die either directly from defoliation or from barkbeetles. Others of somewhat more vigor may survive, but fail to re-establish normal functions after the epidemic passes. These remain as stagheads with numerous dead branches in the lower crown. The most vigorous trees (usually not over 10 to 20 percent of the stand) will very slowly return to normalcy; the tops will fill out well and a full needle complement will develop, but evidence of the infestation will remain in dead twigs which can be seen here and there throughout the crowns.

Reduction of Increment. Another result of needleminer activity is the reduction of radial increment for several years. In those trees which survive but do not fully recover, the growth rings become very abruptly narrowed at the onset of the epidemic and the increment rate remains at the same low level throughout the years after the defoliator disappears. This effect is commonly found in trees which had not reached maturity, but were on poor sites or were very severely defoliated. Cores from trees which fully recover show the same sharp reduction of growth rate during attack, but after activity of the needleminer has ceased there is a gradual increase in the yearly increment until it reaches the same general rate as prevailed before the epidemic. The only trees which can stage such a comeback are the ones which, at the time of defoliation, were young and fast growing; were only lightly infested; or were on exceptionally good sites.

RELATION OF NEEDLEMINER TO MOUNTAIN PINE BEETLE EPIDEMICS

It is typical of nearly all needleminer epidemics that after a few years of severe defoliation, the mountain pine beetle will come in. We know from observation, that successive needleminer attacks can and do kill trees without the aid of other agencies, but this seldom happens in any numbers; the final killing of trees over large areas nearly always follows the invasion of defoliated mature stands by the mountain pine beetle. This association of the two insects seems to have no direct biological relationship, but can be explained by the effect of the needleminer on the trees. Apparently the older trees become so weakened by defoliation that they can offer no resistance to the beetle attacks and amid the abundance of susceptible material the beetle population soon builds up to tremendous proportions. Many trees which might otherwise recover and even trees which have not been defoliated may be overcome by sheer force of numbers. It was in just this manner that the "ghost forests" of Lake Tenaya and Cathedral Creek originated.

AGE AND TYPE SUCCESSION IN GHOST FORESTS

After a mature stand of lodgepole pine has been reduced to a ghost forest, a series of successive steps occur.

1. With the removal of the canopy, reproduction appears. This is usually again lodgepole pine, but mountain hemlock and red fir may come in on favorable sites.

2. As time goes on, the reproduction grows up to form an impenetrable jungle. The old snags begin to fall and become jack-strawed through the area.

3. Eventually the reproduction will thin out and the fallen snags will decay.

4. Two hundred years or so after the beetle epidemic, another park-like mature forest will evolve.

THE NEEDLEMINER AS A PARK MANAGEMENT PROBLEM.

The consideration of extensive devastation and regrowth of lodgepole pine stands in park management plans depends largely upon where these changes are taking place. In the more remote and less used areas, such as Merrick Canyon, the dying condition of the trees is of little moment; this is a natural phenomenon and will affect very few park visitors.

However, in intensively used areas such as Tuolumne Meadows, protection of the mature lodgepole pine is highly important if the recreational value of these areas is to be maintained. Considerable expenditure has been made for roads and campground improvements to attract visitors from severely over-used Yosemite Valley into Tuolumne Meadows and other areas along the Tioga road. In all the most attractive spots lodgepole pine forms the principal forest cover. The loss of canopy with the succeeding jungle of reproduction such as we find in Cathedral Creek, in any of these camp sites or road screen stands would of course render them undesirable for recreational use.

Possibilities for Control

It has been found, in the course of investigations carried on by the Bureau, that there are certain habits which point to the possibility of developing practical methods for preventing needleminer outbreaks in accessible areas: first, the life cycle requires two years so that under ordinary circumstances control measures need be applied on a biennial basis only; second, there is little or no migration of the immature larvae from tree to tree - trees protected in one flight period are then safe for two years even though they be adjacent to others which are heavily infested; third, the eggs and newly hatched larvae are more or less exposed and reasonably easy to reach with insecticides; and fourth, the migration of half grown larvae in the non-flight years is another exposed period during which supplementary control measures could be applied if an epidemic should

reach such proportions as to warrant additional treatment.

Many different insecticides have been tested in recent years and a few, fast breaking emulsions and lead arsenate suspensions, have given sufficient promise to warrant testing on a field scale should an infestation appear in any of the highly valuable stands. Such applications would require the use of a power spray rig (the type now owned by the park) and so would be restricted to campground and roadside areas. The possibility of these control measures injuring wild life is very remote. No suitable control methods have been developed for the less accessible stands, but as mentioned above, the expenditure of funds for such a purpose would probably not be justified.

In stands which have already been killed, the entomological phase has passed, and the only measures which can be taken are those of stand management. In some places, release thinning to hasten the return of a closed canopy might be desirable.

ENTOMOLOGICAL RECOMMENDATIONS

The only recommendations offered for the immediate future are: (1) regular check for the appearance of aggressive infestations on all lodgepole pine stands on or adjacent to roads and campgrounds, and (2) application of protective sprays, on a trial basis, at the first indication of increasing needleminer activity in those areas.

At the present time there is no threat to intensively used stands; the only severe infestations are in relatively remote areas where loss of the lodgepole pine will have little effect upon public use. Needleminer activity at Dog Lake, at the foot of the Forsyth trail in the Tensya drainage, and in the old flare-up areas at Porcupine Flat, however, should be closely watched, for a sudden increase in these infestations might spread to the valuable stands in Tuolumne Meadows or along the Tioga Road.

Results of recent investigations indicate that these valuable stands may be protected by use of sprays. Treatment of aggressive infestations on a field scale test before an epidemic state develops is the next step in progressing toward positive methods of control.

Figure 1. The canopy of this mature lodgepole pine stand has suppressed the growth rate of the reproduction; enough light reaches the ground to permit the development of a grass covered forest floor. This is the type of stand the needleminer attacks.

Figure 2. In 1913, when used by a Bureau of Entomology field party, this was an attractive camp site, having a stand of mature park-like trees and grass covered forest floor similar to that in Figure 1. During the period 1915 to 1918 practically all of the mature trees were killed. By 1938, reproduction had grown up in dense thickets and the grass had disappeared; it will be many years before this area will develop another mature park-like stand.

Figure 1. (No. 11065)

Figure 2. (No. 9996B)

Above:- Mature, undefoliated lodgepole pine near Delaney Creek - a highly susceptible type of stand.

Below:- Snags and reproduction thickets along Forsyth trail - twenty-five years after needleminer and mountain pine beetle epidemic.

(See opposite page.)

Figure 3 (No. 2191)

Figure 4 (No. 6030)

Figure 3. In 1913, when the needleminer and mountain pine beetle had finished invasion of stands along the Tioga Road near Lake Tenaya only ghost forest remained; the reproduction was just beginning to show the effect of release.

Figure 4. In 1925, the reproduction had in many places developed into a dense screen on both sides of the road, replacing the grass ground cover and obscuring scenic beauty of the area.

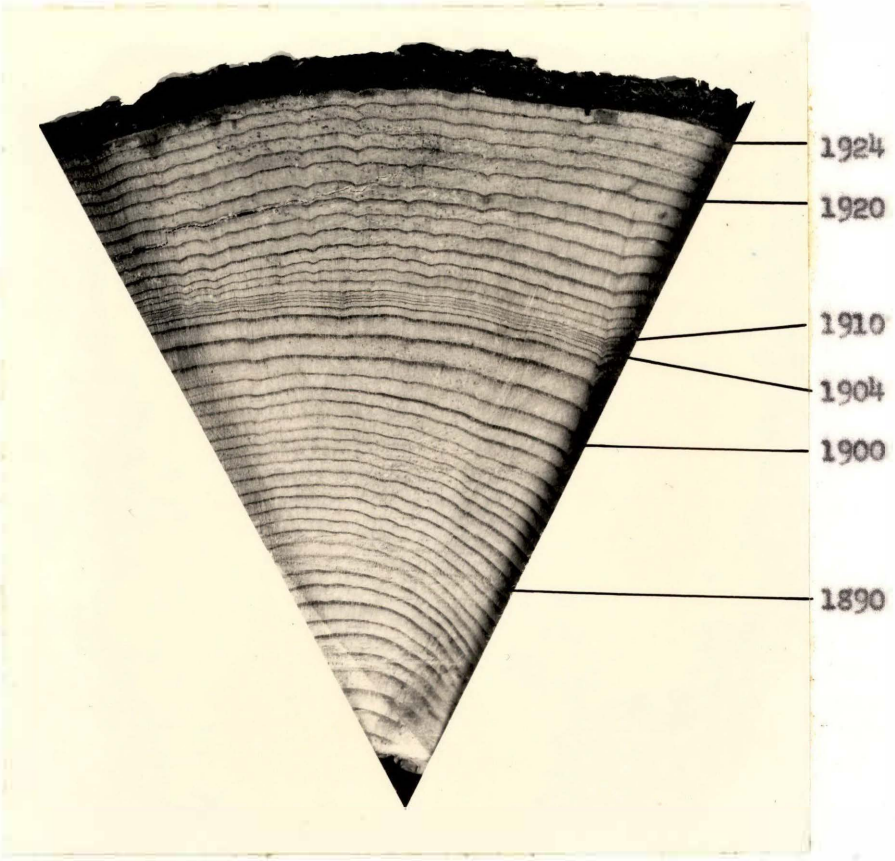

Figure 5. (No. 11067A)

Section of a tree in Virginia Canyon which survived the needleminer epidemic of 1904 to 1910. From 1903 to 1905 the defoliation increased and the growth rate abruptly fell off as a result. During the height of the epidemic, 1905 to 1910, apparently there was barely enough foliage to maintain the tree in a static condition; the increment over the entire 5 year period is about that put on normally in one year. After 1910, the needleminer activity declined; as the needle complement increased, the vigor of the tree gradually returned until by 1914, pre-defoliation growth rate was resumed.

A more mature, less vigorous tree would not have had such powers of recovery; if it had not died during the period of defoliation, it would have survived only as a decadent, slow growing type.

Figure 6. (No. 97070)

Experimental use of power sprayer for control of lodgepole pine needleminer along the Tioga Road. If road screens and campgrounds require protection, this is the only feasible method of attack. It is, of course, limited to areas accessible by road.